The Role of Biogeochemical Dynamics in the Alteration of Uranium Solid Phases Under Oxic Conditions

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Microbial reduction of uranium has been shown to lower groundwater concentrations of uranium in anoxic systems, but such biological alterations must be considered temporary unless long-term anoxia can be guaranteed. Under oxic conditions, the more soluble higher oxidation state of uranium, e.g. the uranyl cation $UO_2^{(2+)}$, is thermodynamically favored. For example, in uranium ore deposits in which uraninite - consisting of reduced U(IV) as $UO_{(2+x)}$ - is the parent material, exposure to oxidizing conditions results in alteration to U(VI) minerals, with the U(VI)-phosphates frequently defining the boundaries of the ore body. U(VI)-phosphates are of interest because of their relatively low solubilities compared to other U(VI) solid phases. Since microorganisms are undoubtedly present in such ore deposits, they likely play a role in the formation of U(VI)-phosphate solid phases. To assist the U.S. Department of Energy (DOE) with long-term stewardship issues associated with bioremediation of uranium, the overall goal of this project is to work with model biological systems to define the mechanisms by which microorganisms facilitate the formation of U(VI)-phosphate solid phases. This information can then be used by DOE to design remediation systems that stimulate biological activity to favor the formation of U(VI)-phosphate phases.

In this project, we are investigating the role of some individual bacterial strains (*Bacillus sphaericus* and *Shewanella putrefaciens*) as well as microbial consortia isolated from the NABIR Field Research Center at Oak Ridge National Laboratory on the alteration of U(VI) solid phases. These strains were selected to reflect a variety of subsurface conditions including aerobic, microaerophilic, and episodically anaerobic. These bacteria or similar species are found throughout subsurface environments. They are believed to influence actinide geochemistry through various mechanisms. These mechanisms are not independent of one another, and together they illustrate the dynamic life cycle that defines the biogeochemical cycle of U(VI).

Supported by Department of Energy under Contract No. DE-AC03-76SF00098.